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A GENERAL-PURPOSE CLASSIFICATION OF SOME EAST-AFRICAN VEGETATION TYPES

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The aim of this work is to field test the general effectiveness of a classification scheme in identifying spatial variations in vegetation at small and medium scales in the Usambara Mountains and on Mt. Meru in Tanzania, East Afrika. To be effective such a system should emphasize both the needs of a general purpose user as well as the needs of vegetation scientists working in vegetation with which they have had no prior experience.

Key words: General-purpose classification, physiognomy, vegetation, Tanzania, East-Africa

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Introduction

In the tropics there is a vital need for the mapping of vegetation, both intensively and extensively. For many users maps are needed which classify vegetation in a manner usable to one without good knowledge of the local flora. These workers, while concerned with the study of vegetation, lack adequate knowledge for using taxonomically based classifications. Therefore the criteria used should refer to the primary elements of physiognomy rather than to the floristic character of vegetation. The classification should be flexible and suitable for mapping actual vegetation (whether natural, semi-natural or cultural) in large scales as well as medium and small scales. The classification should be an easy-to-use, simple and consistent system allowing accurate distinction and naming of vegetation types.

The aim of this work is to test the general effectiveness of such a classification scheme in identifying spatial variations in vegetation at small and medium scales in the Usambara Mountains and on Mt. Meru in Tanzania, East Afrika. The classification system proposed by Dick (1981) for Australian vegetation will be especially field tested on African vegetation. To be effective such a system should emphasize both the needs of a general purpose user as well as the needs of vegetation scientists working in vegetation with which they have had no prior experience.

Material and methods

The field material for this study was collected in December 1988 on an expedition to the forests of northern Tanzania. Members of the Department of Botany of the University of Helsinki did this work in co-operation with the Sokoine University of Agriculture, Morogoro, Tanzania. Financial support for this project was provided by FINNIDA (Project no. 282 097 01-1).

During the expedition I collected substantial notes and materials on the vegetation and plant ecology of Tanzanian montane forests and rainforests. These data were collected from eleven sample plots on the western slope of Mt. Meru, as well as from a large number of collecting localities both on Mt. Meru and in the Usambara Mountains (see Koponen et al. 1990). The sample plot material was collected jointly by all the participants. In addition each participant collected specimens and other data for a personal study. This author emphasized studies of the structure and physiognomic characteristics of certain vegetation types which he encountered. I took measurements, notes, drawings and photographs and these, together with specimens and other jointly collected data provide the material for my study.

The experimental sites

Each of the three forest types which I investigated in Tanzania have special features enabling more effectively the appicability of the physiognomic system of Dick (1981).

A. *Plantation forests on Mt. Meru*

1. *Cupressus lusitanica* forest on the western foot of Mt. Meru. (In/around sample plots 1 & 2)., alt. c. 1830 m, Degree Ref. System Square: 03 36 BC, 13.XII.1988

2. *Pinus patula* forest on the western foot of Mt. Meru. (In/around sample plots 4 & 5). alt. c. 2110 m, Degree Ref. System Square: 03 36 BC, 13.XII.1988

3. *Grevillea robusta* forest on the western foot of Mt. Meru. (In/around sample plot 3). alt. c. 1950 m, Degree Ref. System Square: 03 36 BC, 13.XII.1988

4. *Eucalyptus saligna* forest on the western foot of Mt. Meru. (In/around sample plot 6). alt. c. 2010 m, Degree Ref. System Square: 03 36 BC, 13.XII.1988

The plantation forests on the lower slopes of Mt. Meru provide, semi-cultural vegetation types which are an exellent locality for the field testing of Dick's classification on rather simple vegetation. The main points of interest are:

a. Does the classification succeed in differentiating between rather similar vegetation types at various scales of vegetation mapping?
b. Do the vegetation formulas give a sufficiently accurate picture of the actual vegetation?
c. How does the classification perform in differentiating between cultural or semi-cultural and natural vegetation types?

B. *Natural vegetation on Mt. Meru*

5. *Hagenia abyssinica* forest on the SW slope of Mt. Meru. (In/around sample plot 7). alt. c. 2480 m, Degree Ref. System Square: 03 36 BC, 14.XII.1988

6. *Juniperus ecelsa* forest on the SW slope of Mt. Meru. (In/around sample plot 8). alt. c. 2600 m, Degree Ref. System Square: 03 36 BC, 14.XII.1988

7. *Hagenia abyssinica* forest on the SW slope of Mt. Meru. (In/around sample plot 9). alt. c. 2810 m, Degree Ref. System Square: 03 36 BC, 14.XII.1988

8. Upper limit of *Hagenia abyssinica* forest on the SW slope of Mt. Meru. (In/around sample plot 10). alt. c. 2990 m, Degree Ref. System Square: 03 36 BC, 15.XII.1988

9. *Stoebe kilimandscharica - Heliochrysum* thicket on the western slope of Mt. Meru. (In/around sample plot 11). alt. c. 3210 m, Degree Ref. System Square: 03 36 BC, 15.XII.1988

The natural vegetation of the Meru Forest Reserve on the upper slopes of Mt. Meru provides an exellent ground for the field testing of Dick's classification on more complicated vegetation types. Here, the main points of interest are:

a. Does the classification succeed in differentiating between rather similar vegetation types at various scales of vegetation mapping?
b. Do the vegetation formulas give a sufficiently accurate picture of the actual vegetation?
c. How does the classification correspond to gradual change in the vegetation?

C. *Complex vegetation types in the Usambara Mts.*

10. A patch of vine forest in a streamside gully in secondary dry lower montane forest in the West Usambara Mts. alt. c. 1800 m Degree Ref. System Square: 04 38 CB 11.XII.1988

11. Tropical submontane rainforest in the East Usambara Mts. alt. c. 900 m Degree Ref. System Square: 05 38 BA 9.XII.1988

These forests in the Usambara Mts. provide an exellent ground for the field testing of Dick's classification on very complex vegetation types.

The classification of Australian vegetation by Ross S. Dick

Dr. Ross S. Dick (1981) proposed a new general purpose classification of Australian vegetation. The classification has been widely field tested in Australia (Dick 1981:2), but I know of no wider use outside that continent.

Dick's classification, like several earlier schemes (Küchler 1966), focusses on physiognomic and floristic characteristics of vegetation. The scheme makes use of letter symbols and letter combinations (formulae) to designate different types of vegetation. A short summary of the classification is presented here (for more information see Dick 1981).

Physiognomic features

The word physiognomy refers to the morphology and general appearance of a plant community. The physiognomy of a community includes structural features such as the vertical layers of vegetation, their height and coverage and whether the community is evergreen or deciduous. Also included are such features as the growth form of the plants. Each of these attributes show a wide range of variation which to a large degree reflects enviromental conditions.

In Dick's general-purpose classification, growth form, height and coverage are selected as key criteria (Dick 1981:2). Vegetation is first divided into two major sections: woody and herbaceous vegetation. If both groups are present the vegetation is described first with reference to the dominant woody layer, provided its foliage cover equals or exeeds 20 percent. The dominant woody layer is the one having the greatest biomass. If the cover of all the woody layers is less than 20 percent, the layer which has the greatest biomass is noted first.

Woody growth forms. In Dick's classification the following woody vegetation types are recognized in which the dominant stratum is woody and provides foliage cover of at least 20 percent. A broad division between forest (F) and scrub (S) is made using the height of eight meters as a threshold. This value is similar to that proposed by such workers as Dansereau (1951) to mark the upper limit of the microphanerophyte life form. In using height classes to differentiate vegetation types the classification avoids the problem of distinguishing trees and shrubs according to the number and arrangement of stems (Dick 1981:2). Further subdivision of woody growth forms is also based on the height of the plants. In all, nine height categories are introduced. Thes are marked by using small letter symbols (see Table 1.). The introduction of these arbitrary thresholds is clearly open to criticism. According to Dick (1981:4) this difficulty is evident in all other classifications, and the numerical values proposed in his classification should therefore be acceptable to most workers concerned with vegetation mapping

In Dick's classification further differentation of woody growth forms are made with reference to two additional physiognomic features: succulence or semi-succulence (SC) and the mallee growth form (SM, FM). The term mallee refers to some *Eucalyptus* scrubs and shrublands which are widespread in arid and semi-arid Australia (Parsons 1981). Woody plants with a mallee form of growth have no main trunk, but several stems arising from ground level. The term as generally used refers to approximately 108 *Eucalyptus* species with multiple stems growing from a large underground woody structure, termed a lignotuber (see Parsons 1981). There is variation in the extent to which this multistemmed character is expressed and this means that it can be difficult to classify any given *Eucalyptus* species as a "mallee" or "non-mallee". Using the term for a vegetation which lacks mallee eucalypts seems unjustified, and so the term is not normally used outside Australia.

Special growth forms. Four special growth forms are introduced to the system for a fuller differentation of woody vegetation types. These are: epiphytes (E), tree ferns T), palms (P) and woody lianes or vines (V). The symbols are employed where those plants are regarded as contributing significantly to the distinctive character of the community (Dick 1981:5).

Table 1. A short summary of Dick's general purpose classification system.

A. PHYSIOGNOMIC FEATURES

1. WOODY GROWTH FORMS

	Less than 8 meters in height		More than 8 meters in height	
Evergreen				
	Non-mallee growth form	S	Non-mallee growth form	F
	Mallee growth form	SM	Mallee growth form	FM
	Succulent and semi-succulent	SC		
Deciduous				
	Non-mallee growth form	S*	Non-mallee growth form	F*

Height classes (less than 8 m)			Height classes (more than 8 m)		
Ground	- 0.25m	g	Low	8.0 - 11.9m	l
Dwarf	0.25 - 0.49m	d	Medium	12.0 - 19.9m	m
Low	0.50 - 1.99m	l	Tall	20.0 - 34.9m	t
Medium	2.00 - 4.99m	m	High	35.0m -	h
Tall	5.00 - 7.99m	t			

2. HERBACEOUS GROWTH FORMS

Growth form		Height classes		
Bunch (tussock) grasses	B			
Sward grasses	G			
Hummock grasses	H	Dwarf	- 0.25m	d
Other graminoids	R	Low	0.25 - 0.49m	l
Forbs	O	Medium	0.50 - 0.99m	m
Succulents and semi-succulents	C	Tall	1.00 - 1.99m	t
Ground ferns	N	High	2.00m -	h
Lichens and mosses	L			

3. SPECIAL GROWTH FORMS

Epiphytes **E** Palms **P** Tree ferns **T** Woody lianes (vines) **V**

4. FOLIAGE COVER

Closed	80 - 100%	c	Patchy	10 - 19%	p
Semi-open	59 - 79%	s	Sparse	1 - 9%	w
Open	20 - 49%	o	Very sparse	- 1%	z

Bare ground dominant **D** (i.e. overall cover considering all strata less than 50%.)

B. FLORISTIC COMPOSITION

Herbaceous growth forms. Dick recognizes eight distinctive growth forms of herbaceous vegetation (see Table 1.). These are marked by capital letters. Herbaceous plants may form the dominant stratum in the vegetation, or they may be the principal components of one or more subordinate layers. In Dick's classification, further division of the herbaceous vegetation is made by using five height classes which are marked by small letter symbols (Table 1.). Dick (1981:4) argues that the comparatively small number of divisions in the height classes as well in the classification as a whole is justified so as not to endanger the system with undue complexity.

Foliage cover. In Dick's classification a primary division of vegetation according to its cover is made by separating communities in which foliage coverage equals or exceeds 50 percent from those in which the substratum dominates the landscape. Where bare ground dominates the landscape the community is referred to as desert vegetation (Dick 1981:5, see also Fosberg 1961). The symbol for desert vegetation is D, and it is placed immediately before the first capital letter in the vegetation formula.

Further division on the basis of coverage is made using six cover classes which are marked by small letters (Table 1.). Cover values are obtained first for the dominant layer, and subsequently for other strata if necessary. (For closer discussion of the proposed arbitrary classes and thresholds see Dick 1981:6).

Floristic composition

The floristic composition is one of the essential characteristics of vegetation. It refers to the taxa of plants which form the community. Normally vegetation is an association of different plant species. Usually one dominant or two or more co-dominants may be identified.

In Dick's classification single or paired small letter symbols are used to denote different plant genera. To avoid confusion with the height and cover classes, paired letter symbols are underlined. A number subscript is then used to show the species of each genus. If the principal or subordinate strata in a plant community has a mixed composition, with no dominant or co-dominants, the symbol x̲ is used.

Application

The application of Dick's classification is fairly simple. The structure of vegetation is represented in a formula with four basic components. They are written in the following order: floristic composition (if known), growth form, height and cover. For example the formula for medium semi-open *Acacia* (dominant) forest would be **aFms**. Floristically different communities can be separated by number subscripts: for example the formula **a_1Fms** could refer to an *Acacia albida* dominated community. The formula **a_2Fms** could in turn refer to an *Acacia tortilis* dominated community etc.

Special growth forms are inserted after that part of the formula which refers to the layer in which they are found. For example: medium, closed, mixed evergreen forest with tree ferns, epiphytes and woody climbers would be **x̲FmcTEV**.

If successive strata in the community have the same growth form, floristic character and coverage classification the symbols may be written together: the formula for closed, mixed evergreen forest with tall and medium tree layers would be **x̲Ftmc**.

If a layer of vegetation has two or more herbaceous growth forms of nearly equal importance the symbols may be written together in decending rank order. For example, low semi-open herbage of sward grasses and ground ferns would be **GNls**.

A synusium containing herbaceous and woody growth forms of nearly equal importace is shown by the capital letter symbols for the different forms in descending rank order. If height information is desired they are separated by small letter symbols. The coverage value of the synusia is indicated by adding the appropriate small letter symbol at the end of the formula. For example **BlSdo** would be the synbol for a open growth of low tussock grasses and dwarf evergreen woody plants.

If vegetation is formed by a mosaic of two or more communities, the communities may be arranged in order of areal importance, and separated by a sloping bar symbol (/). For example **Gdc/Cds/Slc** would represent a mosaic of dwarf closed grass, dwarf semi-open succulent vegetation, and low closed scrub.

If two or more synusiae in a community have an equal or nearly equal importance in terms of standing biomass, this co-dominance is indicated by a hyphen (-), placed between the formulae. The tallest synusium is noted first. For more detailed information on the application of the system see Dick 1981: 8-15.

Dick's classification system is very open and for this reason it can be easily applied in mapping vegetation at a wide range of scales. The number of symbols shown in a formula depends on the information available as well as the purpose and scale of mapping. On a smaller scale, a shorter formula can be presented, and this reflects the greater generalization inevitably involved. For example an *Acacia* forest could be marked **F.** (forest) on maps at scales of 1:1 000 000 or larger. On a large scale map (say 1:30 000 or larger) the formula for the same community could be **a_2Fms.x̲Blo** (medium semi-open *Acacia tortilis* forest with a mixed low open tussock grass layer).

The vegetation types

(The treatment of the data for the experimental sites 1. - 10. is incomplete.)

Experimental site 11.
Tropical submontane rainforest in the East Usambara Mts.

Description of vegetation

One of the most conspicuous features of the tropical rain forests around Amani is the large number of species present. For example as many as 300 forest tree species over 10 meters tall occur in the Usambaras, and about 50 of those species are endemic (Pócs 1987). This diversity leads to formidable taxonomic difficulties in species identification. It is obvious that only a person possessing a wide experience on East African rain forests can overcome these difficulties. For most short-term workers a physiognomic approach is the best way to form a general picture of this forest vegetation.

Woody growth forms. The tree layer of the Amani forest can be divided into three layers. The upper tree stratum reaches a height of 41-55m, occasionally even 60m. The upper tree story is not compact, but consists of emergent trees rising far above the middle layer. These giant trees belong to genera such as *Allanblackia*, *Isoberlinia*, *Myrianthus*, *Newtonia* and *Syzygium* (Pócs 1988). Most of them achieve stability by means of enormous plank-buttress roots, and the diameter of their trunks is almost always over one meter. On the experimental site the foliage cover for the upper canopy was estimated to be around 35 percent.

The medium tree story is 25-40 m high and forms an almost continuous leaf canopy. The trunks of the trees are usually slender, but they may reach a diameter of one meter. The crowns of the trees begin high above the ground, and are relatively small because of crowding. These trees belong to a number of genera such as *Afrosersalisia*, *Drypetes*, *Leptonychia*, *Strombosia* and *Trichilia* (Pócs 1988). On the experimental site the foliage cover for the medium canopy was estimated to be around 80 percent.

The lower tree story is rather open and formed by isolated trees which reach 9-24m. Genera such as *Anthocleista* and *Polyscias* are present. Most of these trees can grow in rather deep shade. They normally have slender trunks with a diameter of about 20cm, and may have large leaves. On the experimental site the coverage of the lower tree stratum was estimated to be around 20 percent.

The shrub layer of the forest can be divided into three layers. The upper shrub layer consists of young trees and tall shrubs 4-8m high. Species like *Dracaena usambarica*, *D. laxissima* and *Rinorea* spp. are common (Pócs 1988). The upper shrub layer is normally open: on the experimental site its foliage cover was estimated to be around 20 percent. The medium shrub layer is even more patchy. It is formed by various shrubs 0.5-3.9m high. This layer is rich in the endemic *Memecylon*, *Psychotria* and *Pavetta* species (Pócs 1988). On the experimental site the foliage cover for this layer was estimated to be only around 10 percent. The lowest scrub layer is formed by some dwarf shrubs and tree seedlings less than 0.5 high. Its cover value was estimated to be less than 10 percent.

Herbaceous growth forms. Woody growth forms are clearly dominant in the Amani forest. Relatively few herbaceous plants thrive in the deep shade provided by the dense tree and shrub layers. As a result the experimental site was very poor in herbaceous growth forms. Only some low ferns and forbs were present in the field layer reaching a cover of less than 10 percent. The bare ground between the plants was covered by leaf litter.

In other, more open parts of the forest tall forbs of the *Zingiberaceae* such as *Afromomum usambare* (Pócs 1988) can give the forest a rather different appearance. Also a wealth of aroids, commelinads, balsams, broadleaved grasses etc. can be found growing on roadsides and other disturbed sites.

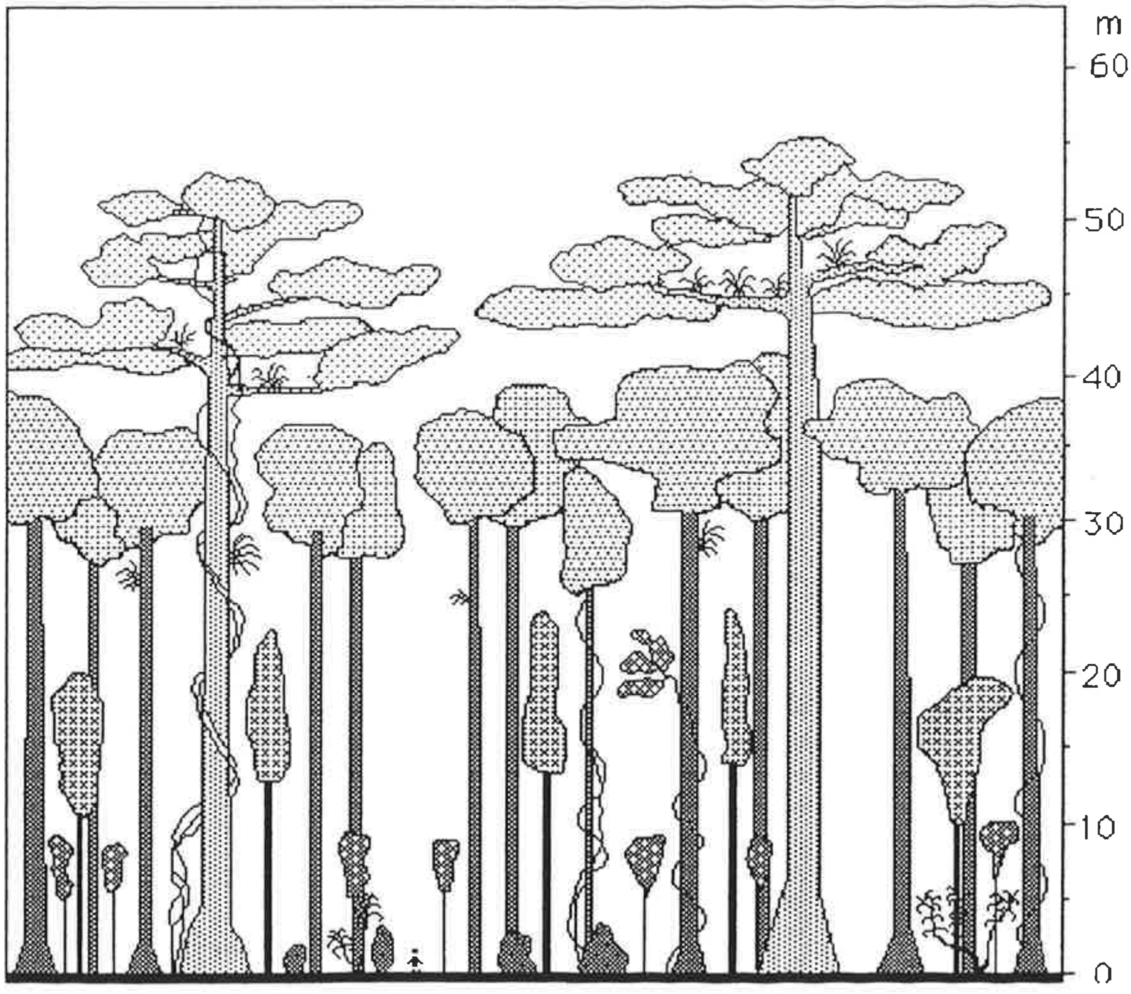

Figure 1. A greatly simpified profile through the submontane rain forest in Amani.

Special growth forms. The air humidity in the Amani forest is very high. Mist formation is also frequent, and as a result, epiphytes are common throughout the forest. The upper and middle canopies are rich in lichens: small, dead twigs can be almost covered by macrolichens, microlichens seem to be more frequent on trunks and thick branches. Light demanding epiphytic ferns such as *Drynaria volgensii*, and flowering plants like various species of the *Orchidaceae* are also abundant in the high canopy. Some epiphytic species such as the Asian nest fern (*Asplenium nidus*) prefer more shade. As a result the nest fern is most common on the upper trunks, but it can be found in rather deep shade as well. Epiphytic mosses seem to be common on the upper trunks. Most algae, mosses, hepatics and filmy ferns (*Hymenophyllaceae*) prefer the constant humidity of the shady lower trunks. In very moist conditions epiphyllic algae, lichens and bryophytes can be found growing on the leaves of trees and schrubs. Also hemiepiphytes such as *Culcasia falciofolia* (Pócs 1987) are present on tree trunks.

In addition to epiphytes, hemiparasitic species such as mistletoes (*Loranthaceae*) are common on the trees of the Amani forest.

Woody lianes (e.g. *Vitaceae*, *Cucurbitaceae*) are common throughout the forest.Some soft stemmed climber species can be found climbing on tree trunks in surprisingly deep shade. On disturbed sites light loving species of *Adenia* and *Rubus* are very common.

No tree ferns were present on the experimental site. However, near Amani the species *Cyathea manniana* is common in moist stream gullies and other wet habitats.

Dick's classification of the Amani rain forest

The formulas for the Amani forest at different scales of mapping:

F

An evergreen forest over 8 meters tall.

xFhc

A evergreen high closed forest with a mixed species composition.

xFhcEV.Sto.

An evergreen forest with a high closed tree stratum with epiphytes and woody climbers and a tall open scrub layer

xFhhmcEV.Stmdo

An evergreen closed forest with two high and one medium tree layer with epiphytes and woody climbers and an open undergrowth of tall, medium and dwarf shrubs

Fc_1,m_1,$m_2$hoEVs_1,$l_1$hcEV$a_1$mo.xStoVmdp

(a_1: *Antocleista grandiflora*, c_1: *Cephalosphaera usambarensis*, l_1: *Leptonychia usambarensis*, m_1: *Myrianthus holstii*, m_2: *Maesopsis eminiii*, s_1: *Strombosia scheffleri*)

An evergreen high forest with three tree layers. The highest tree layer is open, and is formed by the co-dominants *Cephalosphaera usambarensis*, *Myrianthus holstii* and *Maesopsis eminii*. The middle layer is high, closed and formed by the co-dominants *Strombosia scheffleri* and *Leptonychia usambarensis*. The lowest tree layer is open, belongs to the medium height class, and is formed by the species *Antocleista grandiflora*. The upper and middle tree layers have epiphytes and woody climbers. The forest has a three shrub layers with a mixed species composition. The highest shrub layer is tall and open, and it has woody climbers. The medium and dwarf shrub layers are patchy and have no special growth forms.

Conclusions

As the treatment of the data for the experimental sites 1.-10. is incomplete, the discussion and conclusion parts of this study will be published later.

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